Division 1:
Prehospital
Environment

Section 9. Defibrillation (Optional)

TOPIC	CONTENT OUTLINE

Introduction

The student must have successfully completed the following sections prior to participating in this section:

Section 1. Roles and Responsibilities

Section 2. EMS Systems

Section 3. Medical/Legal Considerations

Section 4. Medical Terminology

Section 5. EMS Communications

Section 6. General Patient Assessment and Initial Management

Because of the high number of prehospital deaths attributed to coronary artery disease, this is a subject that continues to receive great emphasis in the training of the EMT-I. This is particularly true in light of recent data which suggests that early defibrillation makes a significant difference in the outcome of patients suffering from ventricular fibrillation. At the time of the submission of this training program to DOT, clear and definitive decisions had not been made as to what level of training information was to be added to give an individual the knowledge and skills necessary to intervene in such catastrophic events. Some systems reserved defibrillation for EMT-Paramedic level personnel, others for EMT-Intermediate, basic EMT, and some had initiated it at the First Responder level. It is for these reasons that this section is offered as an optional section. There is no doubt that early intervention has a great impact on survivability; however, it is up to the local system to determine at what level of training such intervention should be contained within. Therefore this section is presented as optional.

Overview

I. Anatomy and Physiology of the Cardiovascular System
   - A. Anatomy of the Heart
   - B. Physiology of the Heart
   - C. Electrophysiology (Basics)

II. Assessment of the Cardiac Patient
   - A. Common Chief Complaints and History
   - B. Significant Past Medical History
   - C. Physical Examination Pertinent to the Cardiac Patient

III. Pathophysiology and Management
   - A. Pathophysiology of Atherosclerosis
   - B. Specific Conditions Resulting from Atherosclerotic Heart Disease
     1. Angina Pectoris
     2. Acute Myocardial Infarction
     5. Cardiac Arrest/Sudden Death

IV. Dysrhythmia Recognition
   - A. Introduction to ECG Monitoring
   - B. Rhythm Strip Analysis
   - C. Introduction to Dysrhythmias
   - D. Dysrhthmias Originating in the Ventricles

VI. Techniques of Management
   - A. CPR
   - B. ECG Monitoring
   - C. Defibrillation

TOPIC	CONTENT OUTLINE

Objectives

At the completion of this section the student will be able to:

1.9.1. Describe the size, shape, and location/orientation (in regard to other body structures) of the heart muscle.

1.9.2 Identify the location of the following structures on a diagram of the normal heart:

.. Pericardium
.. Myocardium
.. Epicardium
.. Right and left atria
.. Interatrial Septum
.. Right and left ventricles
.. Intraventricular septua
.. Superior and inferior vena cava
.. Aorta
.. Pulmonary vessels
.. Coronary arteries
.. Tricuspid valve
.. Mitral valve
.. Aortic valve
.. Pulmonic valve
.. Papillary muscles
.. Chordae tendinae

1.9.3 Describe the function of each structure listed in Objective #2.

1.9.4. Describe the distribution of the coronary arteries and the parts of the heart supplied by each artery.

1.9.5 Differentiate the structural and functional aspects of arterial and venous blood vessels.

1.9.6 Define the following terms that refer to cardiac physiology:

.. Stroke volume
.. Starling's Law
.. Preload
.. Afterload
.. Cardiac output
.. Blood pressure

1.9.7 Describe the electrical properties of the heart.

1.9.8 Describe the normal sequence of electrical conduction through the heart and state the purpose of this conduction system.

.9.9 Describe the location and function of the following structures of the electrical conduction system:

.. SA node
.. Internodal and interatrial tracts
.. AV node
.. Bundle of His
.. Bundle branches
.. Purkinje fibers

1.9.10 Define cardiac depolarization and repolarization and describe the major electrolyte changes that occur in each process.

.9.11 Describe an ECG.

.9.12 Define the following terms as they relate to the electrical activity of the heart:
- .. Isoelectric line
- .. QRS complex
- .. P wave

1.9.13 Name the common chief complaints of cardiac patients.

1.9.14 Describe why the following occur in patients with cardiac problems:
- .. Chest pain or discomfort
- .. Shoulder, arm, neck, or jaw pain/discomfort
- .. Dyspnea
- .. Syncope
- .. Palpitations/abnormal heart beat

1.9.15 Describe those questions to be asked during history taking for each of the common cardiac chief complaints.

.9.16 Describe the four most pertinent aspects of the past medical history in a patient with a suspected cardiac problem.

.9.17 Describe those aspects of the physical examination that should be given special attention in the patient with suspected cardiac problems.

.9.18 Describe the significance of the following physical exam findings in a cardiac patient:
- .. Altered level of consciousness
- .. Peripheal edema
- .. Cyanosis
- .. Poor capillary refill
- .. Cool, clammy skin

1.9.19 State the numerical values assigned to each small and each large box on the ECG graph paper for each axis.

1.9.20 Define ECG artifact and name the causes.

1.9.21 State the steps in the analysis format of ECG rhythm strips.

1.9.22 Describe two common methods for calculating heart rate on an ECG rhythm strip and the indications for using each method.

1.9.23 Name 8 causes of dysrhythmias.

S1.9.24 Demonstrate on an adult mannequin, the techniques for single and two-person CPR according to American Heart Association standards.

S1.9.25 Demonstrate on an infant mannequin, the technique for infant CPR according to American Heart Association standards.

S1.9.26 Demonstrate proper application of ECG chest electrodes and obtain a sample Lead II.

S1.9.27 Demonstrate the proper use of the defibrillator paddles electrodes to obtain a sample Lead II rhythm strip.

S1.9.28 Demonstrate how to properly assess the cause of poor ECG tracing.

S1.9.29 Demonstrate correct operation of a monitor-defibrillator to perform defibrillation on an adult and infant.

(S) Indicates Skill Objective

TOPIC	CONTENT OUTLINE
Anatomy of the Heart	A. Location, orientation B. Size and dimensions C. Shape 1. Base—top part 2. Apex—bottom pointed part D. Organ layers 1. Pericardium—double-walled protectiver sac surrounding heart a. Visceral—(inner) serous layer b. Parietal—(outer) fibrous layer c. Pericardial fluid is lubricant 2. Epicardium—outermost layer of heart wall muscle 3. Myocardium—thick middle layer of heart wall muscle 4. Endocardium—smooth, inner layer of connective tissue E. Myocardial muscle 1. Specialized muscle cells found only in the heart 2. Striated like skeletal muscle, but similar electrical properties as smooth muscle 3. Composed of contractile proteins arranged in parallel bands—slide together to cause contraction 4. Very dependent on calcium for contraction F. Heart chambers 1. Atria a. Right and left superior chambers of heart b. Less muscular collecting chambers 2. Ventricles a. Right and left inferior chambers of heart b. More muscular; left thicker than right 3. Separation of chambers internally a. Interatrial septum separates atria b. Intraventricular septum separates ventricles c. Both composed of connective tissue as well as muscle G. Heart valves 1. Two sets composed of endocardial and connective tissue 2. Atrioventricular (AV) valves a. Tricuspid valve: between left atrium and ventricle b. Bicuspid (mitral) valve: Between left atrium and ventricle c. Controlled by papillary muscles at apex of ventricles d. Chordae tendinae: String-like fibers connecting valve leaflets to papillary muscles 3. Semilunar valves a. Pulmonic valve: between right ventricle and pulmonary artery b. Aortic valve: between left ventricle and aorta H. Great vessels: Collective name for large vessels that attach to base of heart 1. Vena cava—inferior, superior 2. Pulmonary artery—main artery and two branches

INSTRUCTOR'S NOTES

3. Pulmonary veins—four
4. Aorta

Coronary arteries

1. Exclusive arterial blood supply to heart muscle and electrical conduction system
2. Originate in aorta just above leaflets of aortic valve
3. Left coronary artery
   a. Supplies left ventricle, intraventricular septum, and part of right ventricle
   b. Anterior descending branch
   c. Circumflex branch
4. Right coronary artery
   a. Supplies right atrium and ventricle and part of left ventricle
   b. Posterior descending branch
5. Many anastamoses exist between arterioles of coronary arteries, allowing for development of collateral circulation
6. Coronary veins
   a. Correspond to arterial distribution and drain into right atrium
   b. Coronary sinus: major vein draining left ventricle

Physiology of the Heart

A. Normal blood flow
   1. Superior and inferior vena cava return blood to
   2. Right atrium, through tricuspid valve to
   3. Right ventricle, through pulmonary valve to
   4. Pulmonary artery, to
   5. Pulmonary capillaries in lungs to
   6. Pulmonary veins to
   7. Left atrium, through mitral valve to
   8. Left ventricle, through aortic valve to
   9. Aorta, coronary arteries, and peripheral circulation

B. The cardiac cycle
   1. Right and left atria contract together
   2. Atrial contraction serves to fill ventricles to maximum
   3. Ventricular contraction pumps blood to pulmonary or systemic circulation: Pressure of contraction produces closure of AV valves and opens aortic and pulmonic valves
   4. Systole: contraction phase, usually referring to ventricular contraction
   5. Diastole: relaxation phase, usually referring to ventricles
      a. Much longer than systole (.52 seconds versus .28 seconds)
      b. As rate increases, length of diastole decreases with less reduction in length of systole
      c. Phase during which most coronary artery filling occurs (about 70%)

C. Pumping action
   1. Right-sided versus Left-sided pump

INSTRUCTOR'S NOTES

a. Right atria and ventricles pumping against pulmonary resistance—low pressure system
b. Left atria and ventricles pumping against systemic resistance—high pressure system

2. Stroke volume—amount of blood ejected from ventricle with one contraction
   a. 60–100 milliliters; however capacity to increase is great in healthy heart
   b. Starling's Law of the Heart: up to a limit, the more a myocardial muscle is stretched (by chamber filling), the greater will be its force of contraction (and therefore, stroke volume)
3. Cardiac output—the amount of blood pumped through the circulatory system per minute.
   a. Cardiac output = heart rate × stroke volume
   b. Normal heart rate = 60–100 beats/minute
   c. Normal heart can increase cardiac output three times by increasing rate alone
4. Systemic blood pressure = cardiac output × peripheral resistance

Electro-Physiology

A. Electrical properties of the heart
   1. Automaticity: ability to generate an electrical impulse without stimulation from another source—property of pacemaker cells
   2. Excitability: ability to respond to an electrical stimulus—property of all myocardial cells
   3. Conductivity: ability to propagate an impulse from cell to cell
B. Electrical conduction system of the heart
   1. Function: allows electrical impulses to spread through the heart six times faster than through muscle alone
   2. Sequence of normal electrical conduction
      a. SA node
      b. Internodal and interatrial tracts
      c. AV node
      d. Bundle of His
      e. Bundle branches
      f. Purkinje fibers
C. Function of electrical conduction structures
   1. Sinoatrial (SA) node
      a. Located in right atrium near entrance of superior vena cava
      b. Usually heart's dominant pacemaker
   2. Internodal and interatrial tracts
      a. Pathways that carry impulse between SA node and AV node and spread it across atrial muscle
      b. Impulse travel time: 0.08 seconds
   3. Atrioventricular (AV) node:
      a. Part of area called the "AV junctional tissue" along with some surrounding tissue and the nonbranching portion of the Bundle of His

INSTRUCTOR'S NOTES

b. Responsible for creating slight delay in conduction before sending impulse to ventricles
c. Impulse travel time: 0.08–0.16 seconds
d. No pacemaking properties in node itself

4. Bundle of His
a. Bundle of fibers coming off AV node, located at top of interventricular septum
b. Considered part of the AV junction
c. Makes electrical connection between atria and ventricles

5. Bundle branches
a. Created by bifurcation of Bundle of His into right and left
b. Carry electrical impulse at high velocity to interventricular septum and each ventricle simultaneously

6. Purkinje fibers
a. Terminal ends of bundle branches
b. Network of fibers helping to spread impulse throughout ventricular walls
c. Rapid impulse spread through ventricles: 0.08–0.09 seconds

D. Depolarization
1. Definition: process by which muscle fibers are stimulated to contract by the alteration of electrical charge of the cell. Accomplished by changes in electrolyte concentrations across the cell membrane
3. Spontaneous diastolic depolarization of pacemaker cells
a. Pacemaker cells capable of self initiated depolarization
b. Found throughout conduction system except in AV node
d. Location of cells with pacemaker capabilities and rates of spontaneous discharge (inherent or intrinsic rates)
i. SA node: 60–100/minute intrinsic rate
ii. AV junctional tissue: 40–60/minute intrinsic rate
iii. Ventricles (bundle branches and Purkinje fibers): 20–40/minute intrinsic rate
e. SA node usual pacemaker because it discharges the fastest; pacemaker cells below SA node normally supressed by it

E. Repolarization
1. Process by which cells re-establish internal negativity and are readied for stimulation—return to resting or polarized state

F. Relationship of ECG to electrical activity
1. ECG is record of electrical activity of heart as sensed by electrodes on body surface
2. ECG gives information only about electrical activity; tells us nothing about pump function
3. Isoelectric line: a flat line on the ECG indicating absence of net electrical activity
4. P wave
a. Rounded wave preceding QRS: usually upright (positive) in Lead II
b. Indicates depolarization of atrial muscle

5. QRS complex
   a. Collective term for three deflections following the P wave
      i. Q wave—first negative deflection after P wave
      ii. R wave—first positive deflection after P wave
      iii. S wave—first negative deflection after R wave
   b. All three waves not always present—QRS has many shapes
   c. Indicates depolarization of the ventricular muscle
6. T wave
   a. Rounded wave following QRS complex; usually in same direction as QRS
   b. Indicates repolarization of ventricles
   c. Atrial T wave (atrial repolarization) usually not visible—buried within QRS complex

Assessment of the Cardiac Patient

Common Chief Complaints and History

A. Chest pain/discomfort
   1. Most common sympton of myocardial infarction
   2. Significant history of the chief complaint (history of present illness)—try to determine:
      a. Location of pain
      b. Radiation, if present
      c. Duration
      d. Factors that precipitated
      e. Type or quality of pain
      f. Associated symptoms
      g. Anything that relieves or aggravates pain
      h. Previous episodes
   3. Many causes of chest pain besides cardiac—history important
B. Shoulder, arm, neck, or jaw pain/discomfort
   1. May occur with or without any chest pain
   2. Significant history of chief complaint—same as for chest pain
C. Dyspnea
   1. Often an associated symptom of myocardial infarction or primary symptom of pulmonary fluid congestion due to failing pump
   2. Is subjective; difficult to assess severity
   3. Significant history of chief complaint—try to determine;
      a. Duration, circumstances of onset
      b. Anything that aggravates or relieves (including meds)
      c. Previous episodes
      d. Associated symptoms
      e. Prior cardiac problems
   4. Many causes of dyspenea besides cardiac—attempt to determine history of COPD, cold, fever, etc.
D. Syncope

Includi ds.

1. May be the only symptom of cardiac problems, particularly in elderly patients
2. May be caused by transient or prolonged decrease in heart rate causing drastic reduction in cardiac output and cerebral perfusion
3. Significant history of chief complaint—try to determine:
   a. Circumstances of occurrence (position, etc.)
   b. Duration
   c. Any symptoms prior to syncope
   d. Other associated symptoms
   e. Previous episodes

E. Abnormal heart beat/palpitations
1. Patient's awareness of own heartbeat—usually related to irregularity ("skipping beats") or rapid heart rate
2. Significant history of chief complaint—try to determine:
   a. Circumstances of occurrence
   b. Duration
   c. Associated symptoms
   d. Previous episodes/frequency

Significant Past Medical History in the Cardiac Patient

A. Do not waste a lot of time with past history, as patient is treated based on his/her current symptoms regardless of past history
B. Attempt to determine the following:
1. Is patient taking prescription medications regularly, particularly cardiac medications?—examples:
2. Is the patient being treated for any serious illness?
3. Has the patient ever been known to have:
   a. A heart attack or angina
   b. Heart failure
   c. Hypertension
   d. Diabetes
   e. Chronic lung disease
4. Does the patient have any allergies?

Physical Examination of the Cardiac Patient

A. Primary survey
B. Vital signs and mini-neuro exam:
1. Blood pressure
2. Respiratory rate
3. Rate and regularity of pulse; may be first indication of dysrhythmia
4. Level of consciousness
   a. Determine what is normal for this patient, if possible
   b. Alteration may indicate decreased brain perfusion due to poor cardiac output

C. Secondary survey
1. Look—special emphasis on
   a. Skin color, capillary refill
      i. Indication of adequacy of RBC oxygenation

ii. Indication of pump adequacy

b. Peripheral/presacral edema

i. Caused by chronic back-pressure in systemic venous circulation

ii. Most obvious in dependent parts—check sacral region in bedridden patients

iii. Mild versus pitting edema

c. Be observant for things that indicate patient is being treated for cardiac problems

i. Nitro patch on skin

ii. Implanted pacemaker

2. Listen—special attention to

a. Breathing

3. Feel—special attention to

a. Pulse

i. Rate

ii. Regularity

iii. Equality

iv. Pulse deficit

b. Skin

Management A.

INSTRUCTOR'S NOTES

Peripheral perfusion.

Slow, fast, or irregular pulse may be first indication of dysrhythmias.

ii. Electrocution
iii. Electrolyte imbalance
iv. Hypothermia
v. Trauma
vi. Acid-base imbalance
vii. Drug toxicity
viii. Hypoxia

g. Rhythm disturbances causing cardiac arrest
i. Ventricular fibrillation (V-fib) majority of cases (60–70%)
—primary
—secondary
ii. Ventricular tachycardia
iii. Asystole

2. Basic considerations in management of cardiac arrest
a. Basic life support is essential; paramedic must monitor performance of CPR if delegated to others
b. Primary V-fib easier to abolish than secondary V-fib
c. Defibrillate patient in V-fib as soon as possible—best chance for successful resuscitation
e. Airway can be managed by a number of methods; most sophisticated not always needed immediately
g. Some cardiac arrests managed differently from those secondary to ASHD:
i. Drownings
ii. Hypothermia
iii. Traumatic arrest
h. Anti-shock garment may be useful in cardiac arrests other than those secondary to trauma
i. Cardiac arrest in infants and children rarely a primary event—often due to hypoxia
3. Management of unwitnessed arrest—ventricular fibrillation
4. Management of cardiac arrest secondary to ventricular tachycardia
5. Management of cardiac arrest secondary to asystole
a. Prognosis for resuscitation poor
b. May be the end result of V-fib or electromechanical dissociation
c. Presence of asystole usually indicates
i. Extensive myocardial damage and/or
ii. Severe metabolic deficity, or
iii. High parasympathetic tone
d. If any question as to whether rhythm is asystole or fine V-fib, defibrillation is indicated

Dysrhythmia Recognition

A. Dysrhythmias are most common complication in first few hours
1. Life-threatening—usually ventricular fibrillation
2. Non-life-threatening—may not require prehospital intervention

INSTRUCTOR'S NOTES

See American Heart Association's current ACLS protocols for ventricular fibrillation.

See American Heart Association's current ACLS protocols for ventricular tachycardia.

See American Heart Association's current ACLS protocol for asystole.

TOPIC	CONTENT OUTLINE
	3. Warning dysrhythmias—may be forerunners of life-threatening dysrhythmias—require prehospital intervention
Introduction to ECG Monitoring	A. Review electrical conduction pathway of normal heart 1. SA node 2. Internodal and interatrial tracts 3. AV node 4. Bundle of His 5. Bundle branches 6. Purkinje fibers B. Basic concepts of ECG monitoring 1. ECG is graphic display of heart's electrical activity 2. Body acts as a giant conductor of electrical current 3. ECG obtained by applying electrodes on body surface which detect changes in voltage of cells between sites of the electrodes a. Voltage may be positive going (upward deflection) or negative going (downward deflection) b. These changes are input to ECG machine, amplified, and displayed visually on scope and/or graphically on ECG paper c. Recorded as a continuous curve of waves and deflections called the electrocardiogram d. Monitoring lead: any lead that shows very clear wave forms, very often, Lead II e. Information that can be gained from a monitoring lead or rhythm strip: i. How fast the heart is beating ii. How regular the heartbeat is 4. ECG graph paper a. Standardized to allow comparative analysis of ECG wage patterns; paper moves past stylus at constant, standard speed b. Horizontal lines on graph measure time: i. 1 small box = .04 seconds ii. 1 large box (5 small) = .20 seconds iii. Used to measure duration of complexes and intervals c. Vertical lines on graph measure voltage i. 1 small box—1 millivolt ii. Only pertinent in evaluating calibrated tracings, such as from 12-lead ECG 5. Review of relationship of ECG to electrical events in the heart a. Single cardiac cycle on ECG includes everything from depolarization of atria up to and including repolarization of ventricles b. P wave c. QRS complex d. PR interval e. T wave

A rhythm strip is the paper tracing obtained from a non-calibrated monitoring lead.

Usually 25 mm/sec.

See previous Anatomy and Physiology in Cardiovascular Section.

Review refractory period—relative and absolute.

f. Artifact: deflections on the ECG display produced by factors other than the heart's electrical activity such as:
   i. Standardization (calibration) mark
   ii. Muscle tremors/shivering
   iii. patient movement
   iv. Loose electrodes
   v. 60-cycle interference
   vi. Machine malfunction

F. Ventricular fibrillation
   1. Description: chaotic ventricular rhythm, probably due to many re-entry circuits in the ventricles, with absence of any organized ventricular depolarization or contraction
   2. Etiology:
      a. Wide variety of causes
      b. Most commonly associated with advanced coronary artery disease
   3. Rules for interpretation: totally chaotic undulations of varying amplitude and shape with no discernible waves or complexes
   4. Clinical significance: produces no organized contraction or pulse, resulting in cardiac arrest
   5. Treatment:
      a. CPR
      b. Immediate defibrillation

G. Asystole (cardiac standstill)
   1. Description: absence of all ventricular electrical activity
   2. Etiology:
      a. May be primary event in cardiac arrest; usually associated with massive myocardial ischemia and necrosis
      b. End result of ventricular fibrillation
   3. Rules for interpretation: no discernible waves or complexes; only an isoelectric line
   4. Clinical significance:
      a. Produces cardiac arrest
      b. Prognosis for resuscitation dismal
   5. Treatment:
      a. CPR
      b. Immediate defibrillation
         i. May be fine V-fib
         ii. May have no effect or may convert

Review of Management

Basic Life Support (CPR)

A. Single person adult unwitnessed arrest
B. Two-person adult unwitnessed arrest
C. Infant resuscitation

INSTRUCTOR'S NOTES

See current American Heart Association BLS protocols.

TOPIC	CONTENT OUTLINE
ECG Monitoring	A. Review parts of portable monitor/defibrillator: 1. Paddle electrodes 2. Controls for defibrillator 3. Synchronizer switch 4. Oscilloscope 5. Paper strip recorder 6. Patient cable and lead wires 7. Controls for monitoring 8. Any special features B. Monitoring lead uses three electrodes 1. Positive 2. Negative 3. Ground C. Most common monitoring leads 1. Lead II—best view of P waves, most common in field D. Monitoring through paddle electrodes 1. Used for "quick-look" in cardiac arrest 2. May be used when patient cable inoperable 3. Picks up more artifact than chest electrodes; place chest electrodes at earliest convenience 4. Procedure a. Turn on oscilloscope power b. Apply conducting medium liberally to paddle surfaces or position saline or gel pads c. Hold paddles firmly on chest wall at right upper chest (negative electrode) and left lower chest (positive electrode) d. Observe monitor and obtain tracings if desired E. Monitoring using chest electrodes 1. Review type of electrode used locally 2. Chest electrode placement for Lead II a. Positive—left lower chest wall b. Negative—right upper chest wall c. Ground—variable; placement not critical—place away from other electrodes 4. Avoid placing electrodes over large muscle masses, over large quantities of chest hair, or anyplace that prohibits electrode from lying flat on skin 5. Avoid placing electrodes in same spot that you would place paddles for defibrillation 6. Cleanse skin with alcohol swab and/or abrasive pad a. Removes dirt and body oil for better adhesion, better electrode-to-skin contact (clearer tracing) b. Shave small areas of chest hair if necessary c. Dry skin well—alcohol breaks down electrode adhesive 7. Apply electrodes to skin surface 8. Attach ends of lead wires to electrodes

INSTRUCTOR'S NOTES

a. Explain marking of lead wires for proper placement
9. Plug in patient cable to monitor
10. Adjust gain or sensitivity to proper level
11. Use of audio control optional—be sensitive to patient's response to QRS "beeper"

F. Causes of poor ECG signal
1. Most common cause is poor electrode contact with skin; check for:
a. Excessive hair
b. Loose or dislodged, especially in electrode diaphoretic patients
c. Dried conductive gel on disposable electrodes
d. Poor placement over bony area
2. An initially poor tracing may improve with time as conductive gel breaks down skin resistance
3. Other causes of poor tracing:
a. Patient movement or muscle tremor
b. Broken patient cable
c. Broken lead wire
d. Faulty grounding
e. Faulty monitor

G. Obtaining a paper write-out
1. Technique for placing graph paper in strip writer
2. Adjustment of stylus heat

Defibrillation

A. Definition: The process of passing a current through a fibrillating heart to depolarize the cells and allow them to repolarize uniformly, restoring organized, coordinated contractions
1. "Critical mass" of myocardium must be depolarized, not necessarily entire heart
2. Critical mass related to size of heart, but cannot be calculated for a given individual or situation.

B. Components of the defibrillator
1. Adjustable, high-voltage DC power supply
2. Energy storage capacitor
3. Capacitor connected to paddles by current-limiting inductor
4. Paddles

C. Characteristics of the electrical charge
2. Direct current (DC)
a. More effective
b. Less muscle damage
c. DC defibrillators more portable
3. On the order of several thousand volts
4. Lasts 4–12 milliseconds
5. Strength of shock commonly expressed in energy (joules or watt seconds); Energy (joules) = power (watts) × duration (seconds)

D. Chest wall resistance to electrical charge
1. Lowers the electrical charge actually delivered to heart

Especially in diaphoretic patients.

Demonstrate specifics on equipment used locally or a variety of equipment.

2. Important to lower resistance pathway between defibrillator paddles
3. Factors that influence/vary chest wall resistance:
   a. Paddle pressure
   b. Paddle-skin interface
   c. Paddle surface area
   d. Number of previous countershocks

E. Factors that influence success of defibrillation
1. Duration of ventricular fibrillation
2. Condition of the myocardium
   a. More difficult to defibrillate in presence of hypoxia, acidosis, hypothermia, electrolyte imbalance, drug toxicity
   b. Secondary V-fib (from pre-existing pathology) more difficult to treat
3. Heart size and body weight
   a. Pediatric and adult energy requirements different
   b. Controversial whether size/energy requirement direct relationship exists in adults
4. Previous countershocks
5. Paddle size
   b. Ideal size for adults not established; recommended have equivalent surface area of 10–13 cm diameter circular paddles
   c. Infants: 4.5 cm diameter paddles are adequate; may desire a larger size for older children
6. Paddle placement
   a. Transthoracic placement recommended for emergency situation for adult and pediatric patients
   b. One paddle positioned to the right of upper sternum just below clavicle
      i. Do not place directly over sternum
      ii. Placement over large vessels facilitates current flow
   c. Other paddle positioned to the left of left nipple in anterior axillary line (over apex of heart)
   d. Paddles may be marked for placement.
      i. Apex (positive electrode) and sternum (negative electrode)
      ii. Reversing the paddles does not affect defibrillation, only inverts resulting ECG tracing
   e. Anterior-posterior placement:
      i. One paddle positioned anteriorly over precordium, other behind heart under back
      ii. No evidence of superiority of this method at present in emergency situations
      iii. May be useful when defibrillating infants with adult-sized paddles
7. Paddle-skin interface:
   a. Many types of interface material acceptable
      i. Cream

Eisenberg study: CPR in <4 minutes defibrillation in <8 minutes yields significantly higher resuscitation rate.

Pediatric size paddles are preferable.

ii. Paste
iii. Saline-soaked pads
iv. Pre-packaged gelled pads

c. Creams must be those made specifically for defibrillation, not for ECG monitoring

d. Exercise care with creams and saline pads to avoid "bridging" of charge due to smearing/running of conductive medium

8. Paddle contact pressure
   a. Use firm downward pressure to decrease transthoracic resistance maximally
   b. Do not lean on paddles—they may slip
   c. Pressure also helps to deflate lungs, decreasing resistance
9. Proper functioning of defibrillator
   a. Must actually be delivering energy indicated by machine; routine checks with suitable testing equipment mandatory
   b. Routine exercising of nicad batteries if applicable

F. Energy recommendations for defibrillation
   2. Generally agreed that 360 joules sufficient to terminate V-fib in most patients
   3. Initial defibrillation attempt should be at 200–300 joules; Should be repeated immediately if unsuccessful due to lowered resistance with second shock
   5. Pediatric energy dose recommendations
      a. Initial: 2 jouiles/kg.
      b. Second attempt: 4 joules/kg.
      c. Further energy increase only with physician order

G. Procedure for defibrillation
   1. To be accomplished at earliest opportunity in V-fib
   2. Delegate CPR responsibilities, but monitor effectiveness throughout
   3. Use "quick-look" paddles with conductive medium to evaluate rhythm; stop CPR while observing monitor—5 seconds only
   4. If V-fib present, continue CPR while preparing to defibrillate
   5. Turn on defib power, select energy setting, and charge paddles
   6. Place paddles on chest in correct positions with slight twisting motion to distribute conductive medium
   7. Stop CPR and re-verify rhythm
   8. Clear area and check that no personnel (including self) in direct or indirect contact with patient
   9. Apply firm pressure on paddles
   10. Deliver shock by depressing both paddle discharge buttons simultaneously—observe for skeletal muscle contraction
   11. Leave paddles on chest and immediately reassess rhythm
   12. If any kind of organized rhythm appears on monitor, immediately check carotid pulse
   13. If no pulse or V-fib persists, continue CPR and prepare to repeat defibrillation

INSTRUCTOR'S NOTES

Equivalent to 25 lbs

See current American Heart Association ACLS standards.

See current American Heart Association standards.

Use additional conductive medium if necessary.

TOPIC	CONTENT OUTLINE
Other Considerations	A. ECG telemetry 1. Extent of use of telemetry varies—determined by medical control personnel in a given system 2. Use of telemetry alone without field interpretation of ECG not appropriate a. EMT-I should always verify his interpretation with base physician; ECG may be distorted during transmission b. Field interpretation alone without telemetry *is* acceptable 3. Continuous telemetry transmission not advisable a. Uses excessive air time b. Depletes batteries c. 15–30 seconds of telemetry is usually adequate

INSTRUCTOR'S NOTES

According to local protocols

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